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CROSS-FUNCTIONAL INTEGRATION OF PRODUCT MANAGEMENT AND PRODUCT DESIGN IN APPLICATION SOFTWARE DEVELOPMENT: EXPLORATION OF SUCCESS FACTORS

Completed Research Paper

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Abstract

The industrialization of application software development is a key trend in the software industry. One important element of industrialized development processes is the introduction of a division of work with specialized competencies. Cross-functional integration is a fundamental and well established concept in product development. Its potential has also been recognized in application software development. Many enterprise application software vendors have established product management to complement software development from a business perspective, while R&D primarily focuses on technology aspects. Due to the growing significance of usability and user experience, the product design function has become increasingly important for application software development. However, there is little empirical work concerning cross-functional integration of product management and product design in application software development. The work presented in this paper explores success factors of this cross-functional integration.

Keywords: IS Development, Cross-Functional Integration, Product Management, Product Design

Introduction

One major challenge of the software industry is the industrialization of its product development. Looking at other industries, the concept of cross-functional integration is one key element of industrialization. The general perspective of cross-functional integration in product development has been already researched intensively in Marketing and Innovation Management (e.g., Griffin and Hauser 1992, 1996; Gupta, et al. 1986; Olson et al. 1995). A huge number of studies investigating the boundary conditions for successful software product development have been carried out. The availability of broad experiences within a development team has been identified as one important factor for software development project success (MacCormack et al. 2001). The concept of multi-disciplinary teams has been intensively researched: Agile software development approaches such as Scrum have introduced interdisciplinary teams consisting of members representing business (product owner) and technology (scrum developer). Methodologies such as user-centered design (Norman and Draper 1986) have been introduced to complement the rather technology-driven software engineering perspective with a perspective on the user.

The required competencies for application software development can be roughly grouped in three key areas: 1) business, 2) design, and 3) technology. From a business perspective, usually product managers have the responsibility to define the product strategy and a roadmap, break it down into product development releases with associated business requirements, help the development teams to understand and transform the requirements into work packages, manage the go-to-market and ensure proper product support (van de Weerd et al. 2006, Kittlaus and Clough 2009). Second, from a design perspective, product designers take care of the conceptual and visual design of a product with specific focus on the actual end-user of the system (Cooper et al. 2007, Garrett 2002). From a technology perspective, R&D engineers define the system architecture, model the system from different perspectives, implement and test the system (Sommerville 2006). The activities performed by the different software development team members are not strictly separated and usually overlap. Intensive team work is necessary to be able to leverage the existing competencies in development teams. Agile software development bridges between business and technology competencies, user-centered design focuses on a more systematic interaction between design and technology. However, the interaction between business and design, product managers and product designers, has not received much attention in software development so far. The need for further research in this context has been recognized by other disciplines, e.g. the relationship between Marketing and Design has been recently started to be investigated in Marketing and Innovation Management literature (Troy et al. 2008, Zhang et al. 2011). In this paper we specifically look at the cross-functional integration between product management and product design and explore success factors of this specific cross-functional integration perspective for application software development. We follow a hybrid qualitative and quantitative research approach to explore success factors of cross-functional integration of product management and product design. We collected qualitative data based on 13 semi-structured interviews and analyzed this data to select a set of factors with specific focus on the product management and product design collaboration. Second, we created an online survey to collect quantitative data for the selected factors with regard to successful and non-successful software releases. The collected data was analyzed to find empirical evidence of a possible relationship between the identified factors and the success of a product release.

The remainder of this paper is organized into five sections. First, we discuss related work that has been done in research disciplines such as Marketing and Innovation Management as well as in the IS domain. Next, we articulate our research questions based on the identified research gap and present the methodology we have been following in our research. Third, we present the results of our empirical work focusing on the exploration of success factors for cross-functional integration. Finally, we discuss the implications of our results for research and practice and the limitations of our approach and conclude with a summary including an outlook on future research.

Related Work

The previously mentioned roles of product managers, product designers and R&D engineers participating in application software development can be mapped to the more generic profiles of Marketing, Industrial Design and Research & Development (R&D) in general product development. In the IS context, designers

are responsible for the conceptual design (e.g. interaction and navigation) as well as the visual design of the user interface and can have various role names and descriptions in practice, e.g. Interface Designer, UI Designer or Web Designer. While there are very few empirical works on cross-functional integration between those three parties in the IS literature, there is a considerable amount of literature in the Marketing and Innovation Management domain. Accordingly, the relevant Marketing and Innovation Management literature will be summarized first, followed by related work in the IS domain. Cross-functional integration has long been identified as a key factor driving the success of new products (e.g., Griffin and Hauser 1992, 1996; Gupta et al. 1986; Olson et al. 1995, Ernst, 2002). While the integration of Marketing and R&D has been intensely studied in the last twenty years (e.g., Gupta et al. 1985, 1986; Song and Parry, 1992), the relationship between Marketing and Design has only recently started to be investigated (Troy et al. 2008, Zhang et al. 2011).

Main advantages of cross-functional integration can be seen in the increased communication frequency and improved information flow throughout the organization (Randolph and Posner 1992). These are pillars of a common product understanding and decision consistency, which are both considered to be critical success factors (Sethi 2000). However, several downsides of cross-functional integration have also been reported such as more complex decision making in larger teams and lower efficiency and speed (Olson et al. 1995). Other studies reveal communication problems between Design and Marketing employees and tensions that may arise between the two parties (Bailetti and Litva, 1995, Beverland 2005). Nevertheless, there is a broad agreement, that cross-functional integration to some extent is a key factor to develop successful new products. The Product Development and Management Association's best-practice survey reports that approximately 60% of U.S. firms use cross-functional integration to develop new products (Griffin 1997).

Recent research on cross-functional integration of Marketing, Design and Research & Development focuses on investigating moderator factors that influence the success of integration (Troy et al. 2008), current and ideal levels of integration (Zhang et al. 2011) and the changing role of designers through integration (Veryzer 2005, Perks et al. 2005). Troy et al. (2008) apply a meta-analysis to derive three types of moderator factors that influence the relationship between cross-functional integration and new product success. They differentiate management-controlled moderators (such as integration on team level vs. integration on organizational level), researcher-controlled moderators (such as subjective vs. objective measures of success) and contextual moderators (such as the industry or the country the organization is operating in). Zhang et al. (2011) develop a conceptual framework consisting of 29 activities (e.g. Customer Research) being relevant for Marketing and Design integration. Based on a survey with data from 113 Chinese companies, they contrast current and ideal levels of cross-functional integration in those 29 activities. Veryzer (2005) investigates the roles of Marketing and Design in the development of radically new (or discontinuous) products. The author derives a model that illustrates different factors which determine the ideal level of involvement of Marketing and Design employees in new product developments. Perks et al. (2005) depict the evolution of the role of designers in new product developments and derive three alternative roles based on a sample of 18 case studies. Designers can accordingly take on the roles of functional specialists, multifunctional team members or leaders of the entire new product development process.

Research results from traditional product development cannot be directly transferred to software products. Software products differ from other products in the fact that there are no additional costs for the manufacturing and distribution of extra copies of the product (Cusomano, 2004). Furthermore, software products can be changed easily and updates for sold products can be provided (van de Weerd et al. 2006) These potential advantages come at a price. When one bottleneck is removed, others appear and software development has therefore faced challenges of complexity to an extent that conventional product development has not (Young and Faulk 2010). Another effect of the relative ease of making changes is the increased release frequency in comparison with non-software products (van de Weerd 2006). Due to these numerous differences, a direct applicability of traditional product development research to software may be doubted and further investigation of cross-functional integration in software development is required.

Cross-functional integration and multidisciplinary teams are characteristics of several development approaches which emerged from the Human Computer Interaction (HCI) domain such as User-Centered

Design and Interaction Design (Abras et al. 2004, Veryzer and Mozota 2005, Sharp et al. 2007). In these approaches, cross-functional integration between developers and designers is explicitly incorporated, while the relationship between developers and product mangers is rather neglected. Anderson et al. (2001) show how product development and product design processes can be aligned and which linguistic and cultural problems may evolve when shifting from the traditional system focus to a user focus. Iivari (2004) examines cross-functional integration between developers and designers in an interpretive case study. The author stresses that the mere existence of design resources in a development team does not necessarily cause design improvements. As long as the power of decision remains entirely on the side of the developers, design resources just serve as an image factor. Cooper et al (2007) describe the increasing specialization in software development processes leading to a "Goal-Directed Development" which includes cooperation of managers, designers and developers at an early stage of the product development. However the authors proclaim that most real-life product developments still follow approaches where design plays a secondary or appendix role in the process or even no role at all.

The first proposition in the Agile Manifesto explicitly addresses cross-functional integration by recommending to "Value individuals and interactions over processes and tools" (Fowler and Highsmith 2001). All agile methodologies aim to improve communication and collaboration through frequent inspect-and-adapt cycles. As illustrated by Schwaber and Beedle (2002) in Scrum, the most popular agile approach, these interactions are fostered by so-called "daily scrums", meetings for which all team members come together on a daily basis for a short alignment. These meetings center around the questions what has been achieved since the last meeting, what is planned to be done next (on the same day) and what kind of problems could prevent the accomplishment of the goals. Scrum teams consist of three mandatory roles, two of them representing the formerly discussed functions of product management and product development: While the product owner represents the customer and handles the customer's requirements in the product backlog, the development team is responsible to deliver the product and can be either self-led or managed by a team lead. Furthermore, the scrum master coordinates the scrum process itself. In larger Scrum projects, cross-functional integration is further supported by so called "Scrum of scrums", meetings in which the heads of several scrum teams meet to coordinate multiple teams. In the Agile Development literature, the relationship between product managers (sometimes also referred to as product owners) and product developers has been examined in various works. Judy and Krumins-Beens (2008) review patterns of collaboration and their positive or negative impact in agile teams based on a literature review and a single case study. They review factors influencing successful collaboration and propose unbounded collaboration and collective product ownership as core values of agile approaches which lead to value and innovation. Moe et al. (2009) analyze collaboration between product owner, development team and scrum master based on a single case study. They propose a rotation of leadership between these three parties, depending on the project issue to be solved. Lee and Xia (2010) conduct a comprehensive quantitative and qualitative study on software development agility. Among other aspects, their model describes the relationship between software team diversity, software team response and various project success factors like on-time completion, on-budget completion and provided functionality. Specifically, their results confirm, that software team diversity positively influences the teams' response extensiveness, which again positively affects the provided functionality of the software.

Some recent works explore cross-functional integration in projects combining the two previous depicted approaches in so called Agile User Centered Design. Chamberlain et al. (2006) examine the integration of Agile Development and User-Centered Design in a case study observing three project teams. They note power struggles and communication issues between developers and designers and propose that a balancing power is needed to overcome these conflicts. The authors also identify the lack of resources as an additional cause for collaboration issues. Singh (2008) explores the effects of having two product owners in an agile development case study, one being responsible for back-end functionality and one for usability aspects. The author argues that both usability and developer productivity are increased following this approach in comparison to traditional agile developments (having a single product owner). Hussain et al. (2009) conduct a survey analyzing the current state of agile user-centered design. They explore cross-functional integration on method level and provide evidence that this integration can result in improved usability, overall product quality, and increased end-user satisfaction.

Based on our analysis of existing work, we have identified a research gap in the context of cross-functional integration of product management and product design in application software development. Due to the depicted differences between traditional product development and software product development, research results from the former domain cannot be directly transferred. The existing work on integrating agile development and user-centered design identified interesting aspects. However, there is a lack of empirical evidence. Specifically, there is no existing work that empirically examined which factors determine successful cross-functional integration of product management and product design.

Research Approach

The aim of our work is to empirically investigate success factors of cross-functional integration of product management and product design in application software development. In a first step, we seek to identify general factors impacting the collaboration between product management and product design. In a second step, we investigate the influence of the identified factors on application software release success. Our objectives can be articulated by the following two research questions:

RQ1: What are relevant factors of cross-functional integration of product management and product design?

RQ2: What is the influence of these factors on application software release success?

Methodology

We follow a hybrid qualitative and quantitative research approach to explore success factors of cross-functional integration of product management and product design. Our entire research process can be split into two main steps:

i) Based on a thorough literature review we identified potentially relevant success factors of cross-functional integration in product development. As previously illustrated, there are significant differences between traditional and software product development. Therefore an unmodified applicability of relevant factors cannot be assumed. Consequently, we conducted a qualitative study to explore, if existing factors can be transferred or adapted, if there are contradictions or if there are additional factors concerning cross-functional integration in software development. We collected qualitative data based on exploratory interviews and analyzed this data to select a final set of factors with specific focus on the product management and product design collaboration. Based on an analysis of existing literature, we synthesized our findings by formulating a proposition for each factor. These propositions along with the selected set of factors served as a foundation for the following quantitative study.

ii) For the selected factors we created an online survey to collect quantitative data. Therefore we performed several steps similar to the "domain sampling" approach (Bollen and Lennox 1991; Nunnally and Bernstein 1994) in order to identify a collection of items. They were chosen to represent a good approximation for each factor of interest in the context of application software development. After completing the online survey, we analyzed the collected data to measure the impact of the factors on application software release success. Figure 1 summarizes the two main steps of our research process:

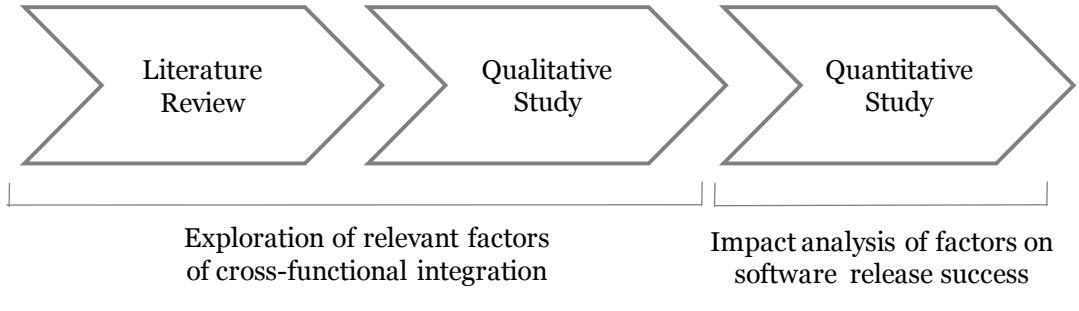

Figure 1. Research Process

Data collection and analysis

As part of the qualitative study, we conducted 13 semi-structured, exploratory interviews, each lasting between one and two hours, to gain insights into cross-functional integration between product management and product design in application software development. We interviewed seven product managers and three product designers from eight German based packaged application software companies. Two of the software companies can be classified as large enterprises (> 10.000 employees), the remaining three were small and medium sized enterprises. Additionally, we included representatives from design consultancies providing rich experiences in our field of study due to their multiplicator roles.

The interviews explored development processes in which the described cross-functional integration is incorporated, roles and responsibilities in these processes and potential pitfalls and problems. The interviews were transcribed and coded with the software package ATLAS.ti. We followed a step-by-step coding process and identified relevant parts of the interviews in a first step. In a second step, we consolidated similar parts of the interviews and merged the corresponding codes. Finally, we associated the codes with the cross-functional integration factors identified in the literature. In our results, we will present exemplary quotes confirming the identified factors. Double translation has been conducted to ensure the correct translation of the original German quotes.

The subsequent quantitative study aimed at finding first empirical evidence of a possible relationship between the identified factors and the success of a product release. It was designed to address product managers from German-based software companies developing packaged application software.

Several steps were conducted to build the online questionnaire. As mentioned before the procedure was similar to the "domain sampling" approach including a review of the results from the literature review as well as the qualitative interviews. Most of the items based on existing studies and were adapted to the object of our investigation. The questions and statements concerning the items required a response on a four-point scale: disagree = 1, partially disagree = 2, partially agree = 3, and agree = 4. In addition we conducted a pretest with 5 industry experts to ensure that there are no unanticipated difficulties. Their comments and suggestions about the questionnaire were also taken into consideration.

The final online survey was structured in three sections: first we showed the test persons a page, on which we explained the meaning of the term product designer as well as a short guideline on how to determine a successful product release. Because of the complexity of the subject, we decided not to introduce pre-defined success measures. Instead, we allowed product managers to subjectively assess product success to minimize effects of uncontrollable market factors, such as competitive response or economic conditions which exist in objective measures. This approach is in line with Troy et al. (2008). The authors showed that subjective assessment of success is suitable for capturing the impact of cross-functional integration with regard to new product development. On the next page, we asked the subjects to remember a successful project out of the last 3-5 years of their career, followed by a number of questions concerning the identified factors. After having completed these questions we asked the subjects to remember an unsuccessful product release, followed by the same questions. We chose this combined query of successful and non-successful releases to avoid a bias concerning social desirability. However, we unfortunately cannot rule out the occurrence of such a bias completely.

During the four week timeframe of the field study, 176 people participated in the survey and 58 people completely filled out the questionnaire. This resulted in a total of 116 product releases surveyed (58 successful; 58 non-successful releases each). The data sample consisted of 15.8% females and 84.2% males with an average age of 39.3 years. The recruitment of test persons took place both online and offline. As part of the online recruiting, two instruments were used: an online-panel (consisting of software product managers) and a German social business network. In addition to the online recruiting of test persons, participants were also recruited through classic forms of off-line recruiting. This was done due to the self selection bias of a pure online-recruitment as well as to increase the representativeness of the sample.

The data collected through the online questionnaire was analyzed using cross tabulations calculated by the Statistical Package for Social Science (SPSS). Crosstabs, often also referred to as contingency tables, are a very common and easy way to demonstrate the "presence or absence of a relationship" between two variables (Brymann and Cramer 1990, p. 151). The analysis was centered around two questions: is there

any relationship between variables of CFI and product release success and if yes, how strong is that relationship. To answer the question, whether there is a possible association between the identified factors and the product release success, we analyzed the frequency distributions of the contingency tables, consisting of the variable successful/non-successful product release and the single items. We therefore performed a chi-square test to determine if the relationship between the variable and the item identified before is statistically significant or has only arisen by chance. Results were regarded as significant when α, the probability of Type I error, was equal or smaller than 0.05 (5%). Cramer's V was used to determine the strength of the relationship between the variable and the item from the contingency tables. This test is considered to be the most suitable chi-square-based measure for nominal associations within m x n tables and provides results which are normalized to the interval [0;1] (Garson 2004, Brymann and Cramer 1990). A value close to 0 means, that there is a very weak relationship between the two variables. In contrast, 1 represents the theoretical maximum possible association. With respect to our study we assume a strong relationship between the variable successful/non-successful product release and an item only when V is equal or higher than 0.3 in conjunction with a low probability of error (α value).

Results

In this section we present the results of our hybrid qualitative and quantitative empirical study to explore success factors of cross-functional integration of product management and product design in application software development.

Key Findings from the Qualitative Study

We have grouped the identified factors into four major dimensions: i) organizational setup, ii) communication, iii) collaboration and iv) decision-making, which will be described in more detail in the following.

Organizational setup

One of the most basic pre-requisites for cross-functional integration and collaboration is the **availability of sufficient resources** from all functions (Judy and Krumins-Beens 2008). Specialized resources might either not be available at all (e.g. in smaller companies who cannot afford) or be restricted to key projects, due to their scarcity. In the cross-functional integration between software product management and product design, the following quotation from a product manager demonstrates that the latter resources can become a bottleneck:

> *"At Company X, there are definitely development departments with a ratio of 1 to 50. 50 Developers and one who defines what should be done. And that just doesn't work. And Company Y has already set it up differently and there, for specific products, the ratio is the other way round. There is one, who codes and seven people, who are concerned with: What is it? How does it look like? How will it be perceived etc.? So this ratio is a big problem."*

Another organizational aspect which determines cross-functional integration is the incorporation of the different functions in the organizational structure. O'Reilly and Tushman (2004) find that new products which are developed by ambidextrous organizations (functions which are integrated at the organizational level) outperform those developed by teams which are integrated at the project level. The interviews suggest that successful companies follow a close organizational alignment of the two functions, manifested in **similar reporting lines** as expressed by a usability consultant:

> *"At Company X it is for example like this, the marketing department is by now subordinated to Ux [User Experience], right. This is actually like, this is something to which we like to reference to, but this is of course also difficult."*

A further organizational aspect which was put forth in the interviews was the relevance of **spatial distance** between the working place of the developers and designers. One of the product managers described how a small spatial distance fostered integration:

> *"You find the designers all the time back at the developers, because they are saying 'Here you forgot something, I need this and that' or for conceptional feedback"*

Summing up we have identified availability of dedicated product design resources, similar reporting lines and spatial distance as selected factors for product release success.

Communication

Organizational factors can build a framework that fosters other aspects of cross-functional integration, like communication. Communication problems are well known characteristics of cross-functional integration (Anderson et al. 2001, Chamberlain et al. 2006, Kusunoki and Numagami 1998) In our context, product managers may serve as communication enablers between designers and developers to couple user-centered and system-centered perspectives on the prospective product or product release. This process seems to profit from direct **types of communication** (e.g. personal meetings) and was referred to as "cross engineering" in one of the interviews by a product manager:

> *"They call that cross engineering. And they spend at least three hours a day with talking to each other, comprehensively, in one room designers and developers and whoever [..] and that seems to work."*

Communication outcomes can be improved by frequent, **bidirectional** communication (Fisher et al., 1997). The latter aspect was also picked up in an interview with a usability consultant:

> *"So concept work is somehow related to dialogue nowadays. So it does not work out any more to get in the requirements and then lock yourself away for four weeks and then in the end come out with a perfect product*."

In conclusion, we have selected the factors type of communication and bidirectionality of communication in the context of the communication dimension.

Collaboration

Based on effective communication, cross-functional integration in software development also embraces concrete collaboration between product managers, designers and engineers. **Common goals** are an important factor for collaboration (Kahn and Mentzer 1998, Tjosvold 1988) shows that common goals are an important prerequisite of successful interdepartmental collaboration which can strengthen work relationships an foster productivity. The latter is closely related to the **efficiency and effectiveness of cooperation,** further factors in this context. As expressed by an usability consultant, ineffective cooperation between product designers and product developers can negatively affect release success.

> "*So this is simply an illusion, to think you could nowadays still make a software, where a software engineer draws any icons or so. This is hell. You cannot bring this to market anymore.*"

Efficient and effective cooperation also requires a clear, mutual understanding of roles as demonstrated by the following quotation of a product manager:

> *"I believe that, in order to run this perfectly, you need interdisciplinary teams, so you need to be versed in bringing the right people together, who a) yes…understand design and usability and b) understand something about functional requirements and business, as it is about a trade off. It does not help to have a very neat product, that you can't earn money with. And then you also need the engineers that can really build this thing. And <u>those</u> companies, that reasonably integrate that and have a clear understanding of the responsibilities who does what in those interdisciplinary teams, seem to somehow be successful."*

In contrast to harmonious collaborations, **conflicts** between departments are a major cause of project failures (Souder 1977, 1987). Especially the relationship between software product development and product design provides significant potential for conflict (Anderson et al. 2001, Chamberlain et al. 2006). These problems were also addressed in the interviews by a usability consultant:

> *"So the main problem is that UX [User Experience]-people in big enterprises usually fight against marketing and against development*."

Summarizing, we have identified efficiency and effectiveness of collaboration, common goals and conflicts as selected factors for product release success.

Decision-making

Communication and collaboration with designers enable information exchange but not necessarily **information use.** Even if information is exchanged, it may not affect actions and decisions in the development of a product release if designers have very limited **decision–making power** (Iivari 2004, Perks et al. 2005). These "pro forma integrations" seem to be a significant issue in software development processes and were repeatedly addressed in the interviews as demonstrated by the following two quotations of usability consultants:

> *"There was this company, they have a usability department, they have persons with the relevant know how, which were responsible for usability, but it had no influence on their products. And that was shocking for all participants. That means, I have to be willing to let my products be influenced and don't have usability only as a marketing gag."*

> *"What is very important, that all who are concerned with UX [User Experience] have the according power to block or put through decisions."*

So finally, we have selected the factors information use and balance of power in the context of the decision-making dimension.

A further potential dimension could be seen in the social context of cross-functional integration, specifically the strength of relationships between the three parties involved. However, we decided not to include this dimension in our final set of factors for the following reasons: First, the benefit of strong relationships is controversially discussed in literature, e.g. in a seminal work by Granovetter (1983) the positive effects of a network of **weak** ties are stressed (in contrast to having few strong ties). Second, there were no indications in our qualitative study that relationship strength would be of importance for our context.

Development of propositions

Following the methodology outlined in figure 1, we synthesized our findings by developing general propositions for each factor respectively. These propositions along with the selected set of factors served as a foundation for the subsequent quantitative study. The following table links each factor to a proposition, along with literature in order to corroborate the proposed linkages.

Dimen-sion	Factor	Literature	Proposition
Organizational setup	Availability of product design resources	Judy and Krumins-Beens 2008	P1: The availability of dedicated product design resources during development has positive impact on perceived release success.
	Organizational structure	O'Reilly and Tushman (2004)	P2: The organizational structure in terms of similar reporting lines has positive impact on perceived release success.
	Organizational location	O'Reilly and Tushman (2004)	P3: The organizational location in terms of spatial distance has negative impact on perceived release success.
Communication	Type of communication	Anderson et al. 2001, Chamberlain et al. 2006, Kusunoki and Numagami 1998	P4: Classical communication approaches are more likely to have positive impact on perceived release success.
	Bidirectionality	Fisher et al., 1997	P5: Bi-directional communication between product managers and product designers positively impacts perceived release success.

Collaboration	Efficiency of cooperation	Brown and Eisenhardt 1995	P6: Efficient cooperation between product management and product design positively relates with perceived release success.
	Effectiveness of cooperation	Brown and Eisenhardt (1995)	P7: Effective cooperation between product management and product design positively relates with perceived release success.
	Common goals	Kahn and Mentzer 1998, Tjosvold 1988	P8: Common goals of product management and product design have positive impact on perceived release success.
	Conflict	Souder 1977, 1987	P9: Conflicts during collaboration of product management and product design negatively relate with perceived release success.
Decision-making	Information Use	Gänswein 2011	P10: Actions and decisions following intensive information exchange have positive impact on perceived release success.
	Balance of power	Iivari 2004, Perks et al. 2005	P11: R&D-centric decision responsibilities have negative impact on perceived release success.

Results of Quantitative Study

The results of our qualitative research combined with the literature review brought some first insights concerning the relationship of cross-functional integration and software product success. A broader investigation is needed to detail and generalize these findings. This has been done by the conduction of a quantitative study, which will be presented in the following. For each identified factor, we will subsequently present a table including the statistical analysis performed for each factor on the item level. As mentioned before, we performed a chi-square test to determine the statistical significance of the calculated frequencies. Due to space limitations we will only report the values of the chi-square tests we calculated for each pair. Table 1 summarizes the results we obtained for the three factors "availability of resources", "organizational structure" and "organizational location".

Table 1. Organizational setup

	N	χ^2 a)	df b)	α c)	V d)	Association
Availability of product design resources (adapted from Judy and Krumins-Beens 2008)						
My company employed staff, which dealt exclusively with product design.	58	17.88	3	0,000	0.393	strong
Product designers were available in sufficient numbers / capacity for the development of the product release.	58	24.07	3	0,000	0.456	very strong
Organizational structure (adapted from O'Reilly and Tushman 2004)						
Product managers and product designers had similar reporting lines / supervisors.	58	7.38	3	n.s.		-
Organizational location (adapted from O'Reilly and Tushman 2004)						
Product managers and product designers were spatially far apart from one another.	58	4.44	3	n.s.		-

a) Pearson's Chi-square
b) Degrees of freedom
c) Residual probability of error α, asymptotic, 2-sided test; n.s. = not significant
d) Cramer's V

As it can be seen in Table 1, there is a highly significant and strong association between the availability of product design resources and the perceived product success. By looking at the contingency tables it can be observed that the corresponding two factors are linked to successful product releases. In the case of non-successful product releases, the respondents rated the two factors as largely not applicable. Based on these results, it can be stated that the availability of dedicated product design resources during development seems to have positive impact on perceived release success.

The association between the organizational structure as well as the organization location and the perceived product release success cannot be considered as statistically significant on a 5%-level.

In Table 2 we summarize the results for the factor group communication. It can be observed that there is a difference regarding classical and modern communication approaches used by product managers and designers during the development of the releases. While the modern approaches (conference calls, video conferencing, and social media) do not show a statistically significant association, we can see a strong association of personal phone calls and meetings as well as group meetings. The use of email only shows a weak association (V=0.262; α=0.046).

Table 2. Communication

	N	χ^2 [a]	df [b]	α [c]	V [d]	Association
Type of communication (based on Fisher et al. 1997)						
Regarding the communication with the design contact about work-related matters, which of the following ways did you use frequently:						
Personal meetings / discussions	58	24.73	3	0.000	0.462	very strong
Personal phone calls	58	10.68	3	0.013	0.303	strong
Group meetings	58	14.24	3	0.002	0.350	strong
Conference Calls	58	0.43	3	n.s.		-
Video conferencing	58	1.22	3	n.s.		-
Email	58	7.96	3	0.046	0.262	weak
Social media	58	1.97	3	n.s.		-
Bidirectionality (based on Mohr and Nevin 1990)						
I always respond to communication from the product design contact.	58	18.41	3	0.004	0.398	strong
The design contact always responds to my communication.	58	35.57	3	0.000	0.554	very strong
The information exchange is based on reciprocity.	58	39.92	3	0.000	0.587	very strong

[a]) Pearson's Chi-square
[b]) Degrees of freedom
[c]) Residual probability of error α, asymptotic, 2-sided test; n.s. = not significant
[d]) Cramer's V

Summing up, new communication approaches do not necessarily seem to influence the perceived product release success. In contrast, the classical approaches do have a significant association with the release success. Therefore our data indicates that classical communication approaches seem to be more likely to have positive impact on perceived release success.

Furthermore all factors relating to bidirectionality of the communication between product managers and designers show a strong association with the perceived release success. In combination with the contingency tables it can be seen, that the design contacts always respond to communication from the product manager within the preparation of the successful product release and vice versa. The exchange of

information between the two parties was thus based on reciprocity. Hence, bi-directional communication between product managers and product designers might positively impact perceived release success.

Table 3. Collaboration

	N	χ^2 a)	df b)	α c)	V d)	Association
Efficiency of cooperation (based on Kahn 1996; Kahn and Mentzer 1998; Ruekert and Walker 1987)						
The Product Manager and the design contact …						
.. also worked together apart from regulations and guidelines.	58	32.15	3	0.000	0.526	very strong
.. shared ideas, information and/or resources.	58	30.29	3	0.000	0.511	very strong
.. have supported each other in fulfilling their duties.	58	35.29	3	0.000	0.552	very strong
.. worked closely together.	58	35.83	3	0.000	0.556	very strong
.. had a good mutual understanding.	58	33.77	3	0.000	0.540	very strong
Effectiveness of cooperation (based on Kahn 1996; Kahn and Mentzer 1998; Ruekert and Walker 1987)						
I am satisfied with the cooperation.	58	45.14	3	0.000	0.624	very strong
The cooperation with the design contact was productive?	58	42.27	3	0.000	0.604	very strong
The design contact carried out his/her commitments to me?	58	26.91	3	0.000	0.482	very strong
Common goals (based on Kahn 1996; Kahn and Mentzer 1998)						
The Product Manager and the design contact have been trying to achieve goals collectively.	58	35.66	3	0.000	0.555	very strong
Conflict (based on Menon et al. 1997)						
The design contact and I had different interests with regard to the release.	58	5.52	3	n.s.		-
There were tensions in cooperation with the design contact.	58	1.01	3	n.s.		-

a) Pearson's Chi-square
b) Degrees of freedom
c) Residual probability of error α, asymptotic, 2-sided test; n.s. = not significant
d) Cramer's V

Table 3 illustrates the results of factors concerning the collaboration of product management and product design. As for the former factors, the frequencies distribution between successful and non-successful product releases was analyzed in the contingency tables in order to find out the presence of possible associations. In general, it can be concluded that in successful product releases the cooperation between product managers and product designers was rated more positive across all factors, in comparison to the non-successful product releases. All factors related to the efficiency of cooperation are of high significance and strongly associated ($V>0.5$; $\alpha<0.000$) to the perceived product release success. According to the

results, successful releases were characterized by close and informal cooperation, shared ideas, information and/or resources as well as mutual support and understanding of product management and product design. Moreover, a look at the effectiveness of cooperation reveals a significant association between the corresponding factors and the perceived product release success. It can be stated that in successful product releases there was a productive cooperation with product designers and commitments were carried out. Consequently, product managers were satisfied with the cooperation. Accordingly, efficient and effective cooperation between product management and product design could be positively related with perceived release success.

In addition, there is a strong association ($V=0.555$; $\alpha<0.000$) between common goals and the perceived product release success. More clearly, in successful product releases the product manager and the design contact have been trying to achieve goals collectively. So, the data indicates that there might be a positive impact of common goals of product management and product design on perceived release success.

However, there seems to be no association between the factors of conflict in terms of different interests or tensions in cooperation with the design contact and the perceived product success. Both items were statistically not significant on the determined 5%-level. This could due to the aforementioned problem of social desirability, since participants might be reluctant to report on conflicts with their colleagues.

Table 4. Decision-making (Part I)

	N	χ^2 [a)]	df [b)]	α [c)]	V [d)]	Association
Information use (based on Antioco et al. 2008)						
The information, exchanged with the designer contact …						
.. led to concrete actions regarding the content of the release.	58	40.606	3	0.000	0.592	very strong
.. led to concrete actions regarding applied methods.	58	25.581	3	0.000	0.470	very strong
.. affected the decision-making process in the development phase of the release.	58	29.500	3	0.000	0.504	very strong

[a]) Pearson's Chi-square

[b]) Degrees of freedom

[c]) Residual probability of error α, asymptotic, 2-sided test; n.s. = not significant

[d]) Cramer's V

Finally, the results from Table 4 show the impact resulting from the information, exchanged with the product designer. An examination of the contingency table shows that all factors apply to the successful product release. It appears that the information exchange between product management and product design led not only to concrete actions regarding the content of the release, but also to the choice of applied methods. Furthermore in successful product releases, the decision-making process in the development phase of the release was affected by the information exchanged. All associations are of high statistically significance and show a high value for Cramer' V. Hence, our data indicates that actions and decisions following intensive information exchange could positively impact release success.

In order to get a deeper knowledge regarding the balance of power, respondents were asked to indicate the dedicated influence of product managers, designers, and developers on decisions in the various stages of preparing the product release. In more detail, the single stages were portfolio coordination, requirements gathering and analysis, prioritization and selection of requirements, design of user interfaces and testing the release. For each stage we asked for the percentage (from 1 to 100) of how much the decision was influenced by product managers, designers, and developers. The results of this part can be seen in Table 5.

Table 5. Balance of power (Part II)						
	Successful product releases			Non-successful product releases		
Stage / Staff	Product Manager	Product Designer	R&D Engineer	Product Manager	Product Designer	R&D Engineer
Portfolio coordination	74.31%	17.57%	8.12%	58.88%	19.40%	21.72%
Requirements gathering and analysis	61.98%	22.41%	15.60%	53.79%	24.74%	21.47%
Prioritization and selection of requirements	69.05%	16.20%	14.22%	55.43%	18.53%	26.03%
Design of user interfaces	25.83%	41.69%	32.48%	25.86%	32.24%	41.90%
Testing of the release	30.10%	19.50%	50.40%	25.17%	17.07%	57.76%

This revealed some interesting results: while product managers dominate decisions concerning the portfolio coordination and the whole requirements management process, product designers dominate the design of user interfaces. Product developers are in the lead regarding the testing of the product release. However, most interesting is the fact that in the non-successful releases, the share of developers' influence on the decisions is always greater in comparison to successful releases. So finally, the data indicates that R&D-centric decision responsibilities might have negative impact on perceived release success.

Contributions and Limitations

In this work we have followed a hybrid research approach to identify success factors and to explore empirical evidence of a possible relationship between the identified factors and the success of an application software product release with respect to cross-functional integration of product management and product design. We contribute to the research by expanding the IS development literature with a new perspective on cross-functional integration of product management and product design integration in application software development.

With the accelerated industrialization of application software development and the growing importance of usability of application software products, our work gives practitioners several important recommendations. First, we identify empirical evidence on the general positive impact of cross-functional integration of product management and product design on product success. This emphasizes the general importance of including product design competencies into the entire product development process. Second, we determine a set of factors where evidence for specific importance for software release success could be identified based on the collected quantitative data: i) Availability of sufficient resources, ii) Promotion of face-to-face meetings and bidirectional communication, iii) Implementation of efficient and effective cooperation between product management and product design based on common goals, iv) Establishment of information exchange and v) Clear assignment of decision responsibilities.

With regard to the decision responsibilities there are some interesting insights. In general it can be concluded that in successful releases, the share of developers' influence on the decisions is always smaller in comparison to unsuccessful releases. This difference is especially evident in portfolio coordination (Δ = -13,6%) and prioritization an selection of requirements (Δ = -11,8%). Another interesting insight is, that despite the vivid discussion going on about the benefits of social media usage in enterprises (Huh et al. 2007, Postman 2009), we could not find any evidence for this effect in the context of our study. In contrast, traditional communication approaches like personal meetings / discussions, personal phone calls and group meetings were used in successful releases significantly more often compared to unsuccessful releases. Finally, we provide first empirical evidence, that a close cooperation between

product designers and product managers might be a success factor that applies not only to traditional product development but also to software product development.

Our findings can be seen as a contribution to software product development and management literature as well as to marketing and innovation literature (outside the IS domain). Some of our findings like the importance of common goals for cross-functional integration support former results from traditional product development literature (Kahn and Mentzer 1998, Tjosvold 1988). Other former results, like an influence of similar reporting lines on CFI (O'Reilly and Tushman 2004) were not supported by the data.

Despite the careful conduction of the study, our research has some limitations. First of all, our results could be biased by the small sample size and the focus on application software companies. It should be noted, that the results could be influenced by a national background, since all of the participants involved in the qualitative and quantitative study were employed at German companies. This applies to both, the qualitative and quantitative study. Since our entire study had a general exploratory character we primary focused on the investigation of correlations. Therefore, we chose a relatively simple statistical analysis approach based on cross-tabulation in combination with chi-square tests. Furthermore, there might be an issue concerning the measurement of the perceived product release success. Although we provided a short guideline within the introduction phase of the online questionnaire on how to determine a successful release, the decision of the test persons regarding the selection of the respective releases finally remains subjective. We are also aware of a time lag between the questioning of the independent variables and the dependent variable, namely the perceived product success. Thus, there is a risk of additional interferences as well as a bias concerning the perception of relationships over time on part of the subjects. Our measure for the identified factors was based on a four-point scale. This could have influenced the variance of individual results. Another issue is related to the selection of the dedicated releases by test persons themselves. Consequently, participants might have chosen product releases with limited design related contents, e.g. bug fix releases.

Conclusion and Implications

Cross-functional integration is a well-established practice in product development. The potential of cross-functional integration has also been recognized in application software development. The aim of our work was to empirically investigate success factors of cross-functional integration of product management and product design in application software development. Our two research questions were focused on the exploration of factors and the measurement of influence of these factors on application software release success. Based on our literature study and our qualitative study we identified a set of factors classified into four major factor dimensions: i) organizational setup, ii) communication, iii) collaboration and iv) decision-making. To explore these findings further, we carried out a quantitative analysis based on an online-survey targeting product managers. We were able to find statistically significant associations for a subset of the identified factors and the corresponding propositions including success factors of cross-functional collaboration in product management and product design.

For practice, various implications can be drawn. First, projects should be set up and organized in a way that allows frequent, personal interaction between product managers, products designers and developers. Moreover, sufficient resources exclusively dealing with design tasks should be allocated to software product developments. Finally, all three mentioned parties should have decision-power in their own area of competence to enable informed decisions.

For research, the results suggest, that cross-functional integration positively affects product release success and that a further investigation of the relationships is promising. Therefore, the research presented in this paper should be seen as a starting point for future empirical investigations on cross-functional integration in application software development. Based on our propositions on the associations between the identified factors and the success of an application software product release, we are planning to setup a structural equation model. This model aims at analyzing the causalities of antecedents and outcomes of cross-functional integration of product management and product design in application software development.

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